

IN THE SPECIFICATION

Please amend page 1 by inserting the following heading between the title of the invention and the first paragraph:

“FIELD OF THE INVENTION”

Please amend page 1 by inserting the following heading on line 7:

“BACKGROUND OF THE INVENTION”

Please amend page 1 by inserting the following heading on line 25:

“SUMMARY OF THE INVENTION”

Please amend page 5 by inserting the following heading on line 30:

“BRIEF DESCRIPTION OF THE DRAWINGS”

Please amend page 6 by inserting the following heading on line 9:

“DETAILED DESCRIPTION OF THE INVENTION”

Please amend page 11 by inserting the following language between the “CLAIMS” heading and claim 1:

“I/We claim:”

Please amend the specification on pages 2-4 by deleting the text beginning on page 2 line 4 and ending on page 4 line 29 as follows:

~~“Thus, the invention can ensure that the piped interface between, for example, the exhaust of a process tool and the inlet to a wet scrubber or other device remains substantially free from obstruction. This can increase the availability of the process tool, reducing maintenance and operating costs.~~

~~Introducing into the body a hot gas purge at a temperature preferably in the range from 50 to 200°C, most preferably in the range from 80 to 120°C, can increase the partial pressure of the water vapour back-streaming from the wet scrubber, thereby reducing the risk of~~

~~condensation within the body. This is because any condensed water vapour would form a cold spot and promote the deposition of materials within the body. Furthermore, the outer surface of the scraping device can be kept hot and dry, and an inert atmosphere can be maintained within the body.~~

~~In principle, any compressed gas may be used. Two commonly available gases are clean dry air (CDA) and nitrogen. Nitrogen is preferred because it will not react with the chemical species typically present in the pipe, unlike the oxygen present in CDA; oxygen will react with silicon hydrides to form solid deposits, for example silane, di-chloro-silane and tri-chloro-silane.~~

~~Preferably, the injecting means comprises one or more orifices for injecting the purge gas into the body, preferably in such a manner so as to minimise the risk of forming eddy currents within the body; such eddy currents can promote solid formation.~~

~~The apparatus preferably comprises heating means extending about the body for maintaining the temperature thereat within the range from 50 to 200°C, preferably within the range from 80 to 150°C. This can also assist in preventing a “cold finger” from entering the body and accelerating the rate of deposition.~~

~~The mechanical scraper may be, in principle, any mechanical device that dislodges particulates from the walls of the pipe as it is moved therein. However, if the scraper was rigid, tough deposits could deform the scraper and damage the shaft. Therefore, a preferred embodiment is a helical coil, due to its innate flexibility and multiple surfaces for removing tough deposits. The coil may take any convenient form, although the greater the number of coils passing any one section of the pipe as the coil is moved therein, the higher the removal efficiency. For instance, the preferred embodiment uses a helical coil with a pitch of around 18mm, and a length of over 110 mm. The scraping device is preferably formed from a chemically inert and mechanically stable solid material, such as stainless steel.~~

~~Preferably, the moving means comprises a piston attached to the other end of the shaft, the piston being reciprocally moveable within a cylinder. A variety of pneumatic cylinders are commercially available (for example, single or double acting, with or without spring return,~~

~~with fixed or rotating shaft), all of which could be used. A preferred embodiment uses a double-acting pneumatic cylinder with a rotating shaft, magnetic piston, and cushioned end stops. Benefits of the double-acting actuator without a spring return are that it can be driven into the retracted position and can easily overcome the forces exerted on the scraper by the incoming process gases, there is no loss of force during extension or retraction, and the rotating shaft enables the helical coil to cut through very hard deposits.~~

~~The magnetic piston enables position indicators, such as reed switches, to validate the cylinder's position (extended or retracted), and feed this information back to the control system to ensure that the apparatus is performing optimally.~~

~~Providing pneumatically cushioned end stops can prevent damage to the ends of the actuator shaft. The actuator shaft should have sufficient mechanical strength to prevent bowing or other mechanical damage. In the preferred embodiment, a solid 12mm diameter stainless steel shaft is used, although in principle the shaft may be formed from any convenient size or material.~~

~~In the preferred embodiment, the actuator stroke is sufficient to clean the end of the inlet pipe without the end of the scraper becoming wetted by scrubber liquid, and to at least substantially fully retract the scraping device from the gas stream passing through the inlet pipe. Thus, the scraping device is preferably at least partially, most preferably substantially contained within the body when the shaft is in a fully retracted position. If the scraper were left in the gas stream it could act as a catalyst to pipe blockage. For example, strokes of 120 and 250mm are used in different embodiments of the invention.~~

~~Pneumatic pressure selection is another important factor. The actuator should supply sufficient force to remove hard and stubborn deposits without damaging other delicate components. Theoretically any positive pressure is acceptable, for example 0–10 bar gauge, although in practice 2–4 bar gauge has been found to be sufficient.~~

~~During normal operation, solid material can build up on the actuator shaft as the scraper is moved into the (cooler) pipe. The apparatus therefore preferably comprises means for preventing particulates deposited on the shaft from being drawn into the moving means as the~~

~~shaft is withdrawn from the pipe. For example, the apparatus may comprise scraping means, such as an annular seal through which the shaft passes, for scraping particulates from the shaft during movement thereof. Without an additional scraper seal these deposits could be dragged back through actuator nose seal. In principle any seal material could be used; to date we have found PEEK™ (poly ether ether ketone) to be the most efficient material for minimising shaft abrasion whilst withstanding the elevated operating temperatures.”~~

Please amend page 6 by inserting the following text before line 10 as follows:

“In a first aspect, the present invention provides apparatus for reducing clogging of a pipe, the apparatus comprising a body having an open end adapted to be detachably connected to an aperture of the pipe, a shaft moveable within and relative to the body, a scraping device attached to one end of the shaft, means for reciprocally moving the shaft to urge the scraping device into the pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the pipe, and, extending about the body, means for injecting heated, compressed gas into the body to inhibit particulate deposition therein.

Thus, the invention can ensure that the piped interface between, for example, the exhaust of a process tool and the inlet to a wet scrubber or other device remains substantially free from obstruction. This can increase the availability of the process tool, reducing maintenance and operating costs.

Introducing into the body a hot gas purge at a temperature preferably in the range from 50 to 200°C, most preferably in the range from 80 to 120°C, can increase the partial pressure of the water vapour back- streaming from the wet scrubber, thereby reducing the risk of condensation within the body. This is because any condensed water vapour would form a cold spot and promote the deposition of materials within the body. Furthermore, the outer surface of the scraping device can be kept hot and dry, and an inert atmosphere can be maintained within the body.

In principle, any compressed gas may be used. Two commonly available gases are clean dry air (CDA) and nitrogen. Nitrogen is preferred because it will not react with the chemical species typically present in the pipe, unlike the oxygen present in CDA; oxygen will react

with silicon hydrides to form solid deposits, for example silane, di-chloro-silane and tri-chloro-silane.

Preferably, the injecting means comprises one or more orifices for injecting the purge gas into the body, preferably in such a manner so as to minimise the risk of forming eddy currents within the body; such eddy currents can promote solid formation.

The apparatus preferably comprises heating means extending about the body for maintaining the temperature thereat within the range from 50 to 200°C, preferably within the range from 80 to 150°C. This can also assist in preventing a “cold finger” from entering the body and accelerating the rate of deposition.

The mechanical scraper may be, in principle, any mechanical device that dislodges particulates from the walls of the pipe as it is moved therein. However, if the scraper was rigid, tough deposits could deform the scraper and damage the shaft. Therefore, a preferred embodiment is a helical coil, due to its innate flexibility and multiple surfaces for removing tough deposits. The coil may take any convenient form, although the greater the number of coils passing any one section of the pipe as the coil is moved therein, the higher the removal efficiency. For instance, the preferred embodiment uses a helical coil with a pitch of around 18mm, and a length of over 110 mm. The scraping device is preferably formed from a chemically inert and mechanically stable solid material, such as stainless steel.

Preferably, the moving means comprises a piston attached to the other end of the shaft, the piston being reciprocally moveable within a cylinder. A variety of pneumatic cylinders are commercially available (for example, single or double acting, with or without spring return, with fixed or rotating shaft), all of which could be used. A preferred embodiment uses a double acting pneumatic cylinder with a rotating shaft, magnetic piston, and cushioned end stops. Benefits of the double acting actuator without a spring return are that it can be driven into the retracted position and can easily overcome the forces exerted on the scraper by the incoming process gases, there is no loss of force during extension or retraction, and the rotating shaft enables the helical coil to cut through very hard deposits.

The magnetic piston enables position indicators, such as reed switches, to validate the cylinder's position (extended or retracted), and feed this information back to the control system to ensure that the apparatus is performing optimally.

Providing pneumatically cushioned end stops can prevent damage to the ends of the actuator shaft. The actuator shaft should have sufficient mechanical strength to prevent bowing or other mechanical damage. In the preferred embodiment, a solid 12mm diameter stainless steel shaft is used, although in principle the shaft may be formed from any convenient size or material.

In the preferred embodiment, the actuator stroke is sufficient to clean the end of the inlet pipe without the end of the scraper becoming wetted by scrubber liquid, and to at least substantially fully retract the scraping device from the gas stream passing through the inlet pipe. Thus, the scraping device is preferably at least partially, most preferably substantially contained within the body when the shaft is in a fully retracted position. If the scraper were left in the gas stream it could act as a catalyst to pipe blockage. For example, strokes of 120 and 250mm are used in different embodiments of the invention.

Pneumatic pressure selection is another important factor. The actuator should supply sufficient force to remove hard and stubborn deposits without damaging other delicate components. Theoretically any positive pressure is acceptable, for example 0 - 10 bar gauge, although in practice 2 - 4 bar gauge has been found to be sufficient.

During normal operation, solid material can build up on the actuator shaft as the scraper is moved into the (cooler) pipe. The apparatus therefore preferably comprises means for preventing particulates deposited on the shaft from being drawn into the moving means as the shaft is withdrawn from the pipe. For example, the apparatus may comprise scraping means, such as an annular seal through which the shaft passes, for scraping particulates from the shaft during movement thereof. Without an additional scraper seal these deposits could be dragged back through actuator nose seal. In principle any seal material could be used; to date we have found PEEK™ (poly-ether-ether-ketone) to be the most efficient material for minimising shaft abrasion whilst withstanding the elevated operating temperatures.

As mentioned above, the apparatus finds particular use in cleaning an inlet pipe to a wet scrubber or other abatement device, and so in a second aspect the present invention provides apparatus for reducing clogging of an inlet pipe to a wet scrubber, the apparatus comprising a body having an open end adapted to be detachably connected about an aperture of the inlet pipe, a shaft moveable within and relative to the body, a scraping device attached to one end of the shaft, means for reciprocally moving the shaft to urge the scraping device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe, and, extending about the body, means for injecting heated, compressed gas into the body to inhibit particulate deposition therein.

In a third aspect, the present invention provides a method of reducing clogging of a pipe, the method comprising detachably connecting to an aperture of the pipe an attachment comprising a body, a shaft moveable within and relative to the body, and a scraping device attached to one end of the shaft; reciprocally moving the shaft to urge the scraping device into the pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the pipe; and injecting heated, compressed gas into the body to inhibit particulate deposition therein.

In a fourth aspect, the present invention provides a method of reducing clogging of an inlet pipe to a wet scrubber, the method comprising detachably connecting to an aperture of the inlet pipe an attachment comprising a body, a shaft moveable within and relative to the body, and a scraping device attached to one end of the shaft; reciprocally moving the shaft to urge the scraping device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe; and injecting heated, compressed gas into the body to inhibit particulate deposition therein.”